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INQUIRY AS A NATURAL PART OF OUTDOOR TEACHING: INSIGHT FROM MOTIVATED EDUCATORS USING ONLINE COURSE AND RESOURCES IN THE CZECH REPUBLIC

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Abstract. *Scientific literacy is decreasing in the Czech Republic and inquiry-based science education (IBSE), believed to enhance it, is used rarely. Meanwhile, outdoor teaching is on the rise, but it is unclear if it could help promote inquiry. This study examines the frequencies of outdoor teaching and IBSE and their relationship in self-reported practice among motivated educators. Two questionnaires were filled out by educators who downloaded teaching resources in 2019 (N = 796) and those who enrolled in an online course in 2020 (N = 745). A high proportion of educators used some form of IBSE. Many of them unexpectedly often involved students in research design as part of IBSE. The frequency of student-designed investigation was correlated with the frequency of outdoor teaching in both samples. Both frequencies increased after the online course. This indicates that involving students in research design can be supported indirectly and that new professional development courses could use the attractiveness of outdoor education. Two groups of active teachers were identified, one focused on inquiry in their own class and the other motivating colleagues to teach outdoors. As they were represented more among primary school teachers, establishing learning communities consisting of both primary and lower-secondary science teachers could bring change to science education.*

Keywords: *inquiry-based science education, online course, outdoor education, professional development*

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Introduction

There is an increasing group of educators, both schoolteachers and home-schooling parents, who devote their time and energy to learning outside the classroom. This trend is observable both in Central Europe and elsewhere worldwide (Činčera & Holec, 2016; Waite et al., 2015). In various studies, diverse forms of learning outside the classrooms have been distinguished, such as outdoor learning (including fieldwork, outdoor adventure activities, and schoolyard or community projects in Rickinson et al., 2014) and outdoor play and learning in natural environments (Gill, 2011). Some authors focus only on school-based outdoor learning, however, outdoor learning is part of education in non-formal settings (e.g. home-schooling, education in museums, botanical gardens or zoos) as described in Malone (2008).

Outdoor Teaching on the Rise

The rise of outdoor teaching and learning at schools in the Czech Republic follows the examples from abroad (such as English Forest Schools or Danish "udeskole"). It lags behind the increase in the number of forest kindergartens, which has been inspired by German or Scandinavian models. In the Czech Republic, there were over 150 forest kindergartens in 2023 (https://www.lesnims.cz/lesni-ms/historie-lesnich-ms.html), but only dozens of forest primary schools. While outdoor teaching is well established in alternative and private schools, the majority of schoolteachers in state schools in the Czech Republic use it rather rarely. Nevertheless, the proportion of schools that report using schoolgrounds for education increased from 60% in 2016 to 65% in 2019 (Činčera & Kroufek, 2021).

There is an increasing number of teachers seeking inspiration for outdoor learning on the online platform Ucimesevenku.cz (English version at https://lessonsingrass.com) and a related Facebook group with 10,3 thousand members (Nepraš & Šikulová, 2021). The accurate proportion of teachers and their frequency of using outdoor education is not known, but in the sample of 119 schools addressed by Vácha and Petr (2013), 46% of schools use the school garden for teaching regularly. Nevertheless, frontal education inside the classroom is reported as the dominant form in science classes at the lower-secondary level (Novosák et al., 2024), probably due to the same obstacles as described by Rickinson et al. (2004). The barriers include: (i)

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concern about health and safety; (ii) lack of confidence in outdoor teaching; (iii) limiting opportunities for outdoor learning due to curriculum requirements; (iv) lack of time, resources, and support.

Outdoor education is generally appreciated for different benefits such as health and wellbeing (Chawla, 2015), improved academic performance in different subjects (Becker et al., 2017), science process skills, students' long-term memory and higher-order learning (Rickinson et al., 2014), confidence, self-esteem and social skills, leadership potential, and environmental responsibility (Chan et al., 2016; Malone, 2008). It is performed by primary school teachers quite often not only for teaching science in connection with nature, but also for various other subjects. This can be assigned to the category "learning in natural environments" rather than "outdoor education". This is clear from the feedback to teaching materials from teachers on the Czech online platform for outdoor learning Ucimesevenku.cz, where the teachers appreciate the materials for Maths and Languages outdoors.

The rationale for outdoor teaching remains vague for many teachers. As teachers usually do not verbalize their own purposes for choosing learning out of school, they often lack arguments dealing with benefits for students that could be used in debates with parents, colleagues, or headmasters. Teachers may also use general arguments not tightly aligned with their particular curricula. Czech teachers have an opportunity to find arguments regarding the benefits of learning out of the classroom in the publication Tajemství školy za školou [The Secret of the School behind the School] (Daniš, 2018) or through online courses at Ucimesevenku.cz. These are grouped by researchers (Waite, 2020) as Healthy Bodies and Positive Lifestyles; Social, Confident and Connected People; Creative and Self-Regulated Learners; Effective Contributions and Collaboration; Care for Others and the Environment. The impact of teachers' beliefs on their practice during a professional development program on outdoor learning was analyzed for secondary teachers in England (Glackin, 2016). Teachers who successfully taught outside generally held social constructivist beliefs about learning and valued opportunities that allowed their students to conduct 'authentic' science. Teachers who were less successful in teaching outside held traditional learning beliefs and appreciated the outdoors because it was a new and entertaining learning environment for their students.

Inquiry Science Education and Scientific Literacy

When focusing on opportunities to develop students' science process skills, teachers may take advantage of inquiry-based learning, which has been very common in English-speaking countries for more than 30 years and has been widely promoted in educational practice, especially in science education (Furtak et al., 2012; Hmelo-Silver et al., 2007). In inquiry-based science education (later on IBSE), students are exposed to authentic problems or natural phenomena in real-world contexts – they are expected to acquire knowledge through observations, explanations, and experiments with real-world problems (Bybee, 2002; de Jong et al., 2013; National Research Council, 2012; Pedaste et al., 2015).

Although promoted internationally through EU recommendation reports and dissemination projects, the impact of IBSE on scientific literacy (e.g. measured by PISA) is still debated (McConney et al., 2014; Sjøberg, 2018), however, it has been shown as effective in supporting students' engagement in science. The relationship between the frequency of IBSE and results in scientific literacy is not straightforward. When PISA's composite variable (IBTEACH) was used, there even was a negative correlation between the level of inquiry and scientific literacy scores. However, when the IBTEACH index was disaggregated and each questionnaire item was mapped separately, the results showed contrasting and non-linear patterns (Oliver et al., 2019). The non-linear relationship can be illustrated by these items: Students who reported spending time in the laboratory doing experiments in some or most lessons performed better than students who experienced it in every lesson or never. The same is true for "drawing a conclusion about an experiment they performed" and "doing an investigation to test ideas". For the item "students are allowed to design their own experiments", the pattern is non-linear, with high levels of scientific literacy linked to the low frequency of this item but with declining scores when this item is reported as "never or hardly ever".

The authors underscore the question of optimal frequency, quality, and purpose of different inquiry activities. The quality of IBSE is naturally what matters most, but this can only be assessed during classroom observation (Kotuľáková et al., 2022; Oliver et al., 2019). Among various inquiry activities, designing and performing investigations and drawing conclusions are the most important factors linked to scientific literacy.

In the Czech context, using IBSE is observed as very rare; less than 4% observed lower secondary science lessons in the report of the Czech School Inspectorate (Česká školní inspekce, 2018). Radvanová et al. (2017) have found a significant increase in the use of IBSE in the sample of upper secondary teachers from 3.43% of lessons in 2012 to 6.82% of lessons in 2017. Similarly, Činčera and Kroufek (2021) have stated that 6% of teachers report using the whole inquiry cycle in their practice in a 2019 survey.

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Czech school lessons are dominated by the transmission approach in science classes (Novosák et al., 2024), IBSE frequency has not been mentioned in this report at all. Recommendations focused on different aspects of "active learning", which can be directly linked to IBSE as measured by PISA. Most students have rarely or never the opportunity to promote their science process skills such as working with graphs and tables, designing and conducting observations and experiments, or interpreting results. The report has revealed that most students have difficulty with designing the experiment. The report has not proved higher levels of scientific literacy among students who experience active learning (students' experiment, own observation of natural phenomena and events, work with error), but the frequency of active learning positively influenced their attitude to science. Similarly, in the UK, Ofsted (Office for Standards in Education, Children's Services and Skills) has encouraged the use of practical work in school science, criticizing "poor opportunities for students to plan, carry out, and evaluate investigations independently" (Ofsted, 2013, p. 10).

According to Novosák et al. (2024), the teachers would appreciate practically oriented support for their pedagogical work (e.g. teaching supplies and kits and methodological guides, worksheets, suggestions for experiments) and higher overall coherence of science education (e.g. continuity of the curriculum across the educational stages, cross-curricular and literacy links within topics). The report has concluded that professional development of teachers is essential for the introduction of innovations in science education.

Professional Development for Outdoor Education and IBSE in the Czech Republic

As professional development in the Czech Republic does not follow any rigorous plan, credit system, or certification, it is rather optional. Teachers use different opportunities, such as courses organized by NGOs and universities, usually only short-term ones. Online courses have been quite rare in this field until recently. The online course "Učíme se venku" (Teaching Outdoors) has been one of the first of this kind in the Czech Republic (piloted in 2019/20), later other online courses for science education (e.g. for IBSE or climate change education) have followed.

In the Czech Republic, both outdoor teaching and using IBSE are promoted by NGOs (such as TEREZA, Educational Centre) developing teaching materials made available online and promoted through social media. There is still a difference between the numbers of teachers and other educators interested in outdoor teaching (a Facebook group with ca. 10.3 thousand participants in March 2024) and IBSE (5.4 thousand); the number of teachers joining these Facebook groups has been increasing steadily. The IBSE approach is introduced to students at universities but with limited success, as they often do not have the opportunity to implement the method under the supervision of experienced teacher mentors during their studies and later on as novice teachers. An innovative platform called Hyperspace (hyperspace.cz) is focused on implementing inquiry-based teaching and formative assessment at primary and lower-secondary level. It contains methodological materials, videos from real lessons, and pedagogical diagnostic tools (Stuchlíková et al., 2023).

According to a report of the Czech School Inspectorate (Novosák et al., 2024), the majority of lower secondary science teachers consider collaboration with colleagues as most useful for their professional development, 20% of teachers value professional development courses, and only 10% esteem online courses. At the same time, the majority of teachers in the Czech Republic do not have any experience with reflective practices within school professional learning communities (Smetáčková & Vozková, 2021) and thus the real benefits from their collaboration with colleagues remain questionable.

Introduction of both outdoor teaching and IBSE requires changes in educational strategies, classroom management, or the role of teachers. The teachers search for opportunities to enhance their self-efficacy, gain support, arguments, resources, and best practice examples to ascertain themselves and convince their colleagues, principals, and parents that such a change of educational methods is beneficial to the students. Cooperation with colleagues is considered a part of teachers' self-efficacy (Bandura, 2007). Tschannen-Moran and Woolfolk Hoy (2001) have defined it as the teachers' beliefs in their own abilities to effectively teach a subject to the students, ensure student participation and achieve the desired results. Researchers also add the component of collaborating with colleagues and parents and participating in the school management (Yang & Wang, 2019; Smetáčková et al., 2017). In the previous study, primary school teachers were more active than lower secondary school teachers both in the frequency of outdoor teaching and using IBSE, in collaborating with colleagues, and in influencing decisions within the school management (Čiháková, 2021).

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Research Aim and Research Questions

As outdoor teaching about nature brings up new students' questions naturally, it is interesting whether the higher frequency of outdoor teaching promotes some aspects of inquiry-based education, specifically whether it increases the frequency of students' questions and opportunities for students designing their own research. Using self-reported behavior of teachers in questionnaires and the limitations of this approach is discussed below. Opportunities for students to formulate research questions and design their own research may be reported by teachers who use IBSE deliberately and also by teachers who have not attended any formal course on IBSE, or those who respond that they do not know the IBSE approach at all.

However, it is not clear whether there is a group of teachers who use both approaches (outdoor teaching and IBSE) intentionally, as only those could serve as ambassadors of both outdoor teaching about nature and promoting the IBSE approach among their colleagues in school learning communities. Therefore, specific questions on teachers' self-efficacy (subscale: collaboration with colleagues) and the number of colleagues in the same school practicing outdoor teaching were included.

The impact of the online course from questionnaires (pre-test and delayed second post-test) for the online course "Učíme se venku" taking place in 2020 on the frequency of outdoor teaching and IBSE was evaluated. Another set of data from an online questionnaire filled out in 2019 by the teachers who downloaded teaching materials from the "Ucimesevenku.cz" website (designed by TEREZA, Educational Centre) was analyzed.

In this study, the following questions were addressed:

RQ1. Does the online course increase the frequency of outdoor teaching?

RQ2. Does the online course increase the frequency of IBSE?

RQ3. Is the frequency of using IBSE correlated with the frequency of outdoor teaching?

RQ4. What are the characteristics of teachers regarding outdoor teaching, using IBSE and influencing other colleagues – are these traits correlated among primary and lower-secondary teachers?

Research Methodology

General Background

The research was carried out as an evaluation of an online course that was piloted in the spring of 2020. It was offered as a voluntary free professional development program for school teachers and other educators ($N = 745$) at the Ucimesevenku.cz platform. The same website offered free teaching resources focused on outdoor education with inquiry elements. Educators ($N = 796$) were asked to fill out the questionnaire before downloading free resources (February – November 2019). Post-questionnaires for the online course were distributed in 2021. As it was still during Covid restrictions when schools in the Czech Republic were closed, the teachers self-reported only the activities they used during online education. In this study, only data from delayed post-questionnaires from the school year 2022/23 were analyzed.

The study was conducted as action research with the aim of improving both the online course and teaching resources and tailoring other offered professional development activities (new online courses, webinars, Facebook group challenges, etc.) for the targeted audience. Another objective was to identify experienced teachers to address them as ambassadors of both outdoor teaching and IBSE and to reach them to participate as tutors in new courses.

Online questionnaires of self-reported teachers' behavior were used, and the answers were categorized for quantitative analysis. The correlation between the frequency of IBSE and outdoor teaching was analyzed. The impact of the online course was examined for different items separately using exploratory multivariate analysis to find the characteristics of different groups of teachers active in IBSE and outdoor teaching.

Sample

Two different datasets were used for this study. Both were samples of educators interested in outdoor teaching. Online Google questionnaires were used for addressing teachers on the website Ucimesevenku.cz. Answers were obtained from respondents downloading free teaching materials from Ucimesevenku.cz in 2019 ($N = 796$), later called the DOWNLOAD dataset.

Further, responses from educators enrolling in the online course "Učíme se venku" in 2020 ($N = 745$) were used, later called the ONLINE COURSE dataset. The online course was focused on arguments about the benefits

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of outdoor education, and it showed how to acquire or create and use simple equipment for outdoor education. To assess the impact of the online course, two post-questionnaires were distributed. However, because of school closures during the Covid pandemic, only the data from the delayed post-test that was distributed in 2022/23 ($N = 74$) were used in the analysis.

For the questions regarding the school practice, only subsets containing schoolteachers were used (RQ1, RQ2, and RQ4). Answers from the whole sample (including other educators) were used for the correlation between the frequency of outdoor teaching and using IBSE and the frequency of involving students in the investigation design.

Specifically, there were 278 primary school teachers (ISCED 1), 144 lower-secondary school teachers (ISCED 2), and 436 other educators (such as home-schooling parents, preschool and early childhood educators, educators in non-formal settings) in the DOWNLOAD dataset. "Elementary" school teachers (the term is used synonymously with "primary" school teachers throughout the text) correspond to ISCED 1, and "lower secondary" correspond to ISCED 2.

There were 252 primary school teachers, 107 lower-secondary school teachers, and 358 other educators in the ONLINE COURSE dataset. In the delayed post-questionnaire in 2022/23, only 98 participants sent their responses (74 teachers). Only this subsample of teachers was used for further analysis of the impact of the online course on the frequencies of different teaching strategies. The results therefore show the impact on the highly motivated teachers, as discussed below.

Instrument and Procedures

The questionnaires were designed to assess the effect of the course and to reveal the potential correlation between the frequency of outdoor teaching and using IBSE before and after the online course or using provided teaching materials. Items have been adopted from Smetáčková et al. (2017) for self-efficacy and from the Czech School Inspectorate survey for frequency of outdoor teaching and IBSE steps to be comparable with the surveys at the state level. Both questionnaires included a subset of identical questions (on the frequency of outdoor teaching and involving students in investigation design) and other questions unique for each dataset. The DOWNLOAD dataset focused on teachers' practice, frequency of different IBSE steps (see below), and other items not included in this analysis (such as teachers' experience in outdoor teaching during their university study, use of different environments for outdoor teaching, or self-declared knowledge of IBSE principles). The ONLINE COURSE dataset included questions on teachers' self-efficacy and planning. There were identical questions in the pre-questionnaire and the delayed post-questionnaire. The post-questionnaire contained additional questions on participation in other online courses of other professional development programs concerning IBSE in the due course.

Responses were categorized as follows: frequency of outdoor teaching (in DOWNLOAD dataset): 0 = never, 1 = rarely, 2 = 2x per term, 3 = monthly or more often, 4 = weekly; frequency of outdoor teaching (in ONLINE COURSE dataset) : 0 = never, 1 = rarely, 2 = 2x per term or more often, 3 = monthly or more often; frequencies of IBSE steps, such as involving students in investigation design (later as Students' design frequency, IBSE_design in Figure 5), frequency of students formulating questions (IBSE_questions), recording data and drawing a conclusion: 0 = never, 1 = rarely, 2 = 2x per term or more often, 3 = monthly or more often.

Other responses were categorized as follows: Teacher plan ("I prepare a year plan for outdoor teaching according to observable nature phenomena": 4 = strongly agree, 3 = agree, 2 = disagree, 1 = strongly disagree), Arguments ("I know why to teach outdoors… but I don't talk about the reasons because I'm not sure how to persuade others." = 0, "and I know where to find arguments to persuade others" = 1, "and I share the arguments with some colleagues" =2, "and I use them regularly when talking to other colleagues, parents or school management." = 3)

The subscale "Influence on School Management" from the Czech teachers' self-efficacy scale created by Smetáčková et al. (2017) was applied to assess the influence of teachers on teaching strategies used in their school (such as IBSE or outdoor education) and their potential to change the practices of their colleagues. This subscale was adapted from the original Bandura's teacher efficacy scale (Bandura, 1997) consisting of questions with a 9 point scale. Smetáčková et al. (2017) used a 5-point frequency scale anchored with the expression of frequencies ranging from "never" to "always" that was piloted in a quantitative study ($N = 583$). The items included the following statements: I am able to express opinions on an important issue (i), I am able to contribute to solving a problem (ii), I am able to influence decisions at school (iii), I am able to enforce change in school practice among colleagues (iv). For this study, the variable labeled "Efficacy" was calculated as average from these 4 items, coded as follows: never = 0, rarely = 1, sometimes = 2, often = 3, always = 4. The answer "I am not able to decide" was coded as a missing value; teachers who did not respond to one or more questions were excluded from the analysis.

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Data Analysis

All variables used in the analysis came from self-reporting data in questionnaires and, therefore, are of ordinal character. Intervals between individual values were assumed to be roughly comparable, and their values were therefore analyzed as numeric (quantitative) variables with normal errors. Changes between their values before enrolling on the online course and after it were compared by an paired two-sided t-test. The correlation between outdoor teaching and the frequency of involving students in investigation design and teaching at a primary school was examined using a simple (regression) linear model to express shared variation between these variables using R^2 and to perform a significance test using F-statistic.

A number of variables for individual teachers were collected, and therefore mutual interrelationships across the whole set of measured variables could be examined. Such mutual correlations among the teachers' responses were identified using Principal Component Analysis (PCA) of their correlation matrix. The PCA results showed the amount of shared variation (proportion of variation accounted for by the first and second principal axes of variation) and the contribution of individual variables to these principal axes (variable scores). PCA was calculated using package vegan (Oksanen et al., 2020, ver. 2.5-7) from the R environment (R Core Team 2021).

PCA was also used to summarize teachers' responses in the four variables, capturing the frequency of IBSE steps (i.e. formulating questions, involving students in investigation design, recording data, and drawing a conclusion). As all these variables are expressed on the same scale, PCA on covariance matrix, i.e. without standardization was used. Here, the first axis accounted for 75.3% of the total variation in these four variables, indicating high correlations among them. This permitted the use of the teachers' score of the first axis of this PCA as a representative value summarizing most of the relevant variation in these four variables (further called IBSE score). The correlation of this IBSE score and outdoor teaching frequency was again analyzed using a linear model. All analyses were conducted in the R environment, version 4.1.2 (R Core Team, 2021).

Research Results

After the online course, both the frequency of outdoor teaching and the frequency of student-designed research reported by teachers increased. Teachers' planning of outdoor teaching activities and their knowledge of arguments for outdoor teaching increased as well. However, reported teachers' self-efficacy with respect to influencing colleagues and the school as a whole decreased. Nevertheless, 8 teachers reported higher teachers' self-efficacy after the course and 13 teachers reported an increased number of colleagues in their school outdoor teaching (ONLINE COURSE dataset).

The frequency of IBSE: 29.6% of teachers gave students the opportunity to design their own investigation twice per term, and 11.6% of teachers did so monthly. The results were similar for primary and lower-secondary school teachers. 15.8 % of teachers taught outdoors monthly or more often (ONLINE COURSE dataset).

In the dataset of participants downloading teaching materials, 26.5 % of teachers taught outdoors monthly, 29% of teachers gave students the opportunity to design investigation twice per term, and the other 25.2% of teachers did so monthly. Among other educators, the frequencies were higher: 44% of educators taught outdoors monthly or more often (DOWNLOAD dataset).

Completing the online course increased the frequency of outdoor teaching among teachers in delayed post-test (Figure 1). The frequency of outdoor teaching is coded: 0 = never, 1 = rarely, 2 = 2x per term or more often, 3 = monthly or more often; t (41) = -2.231, p = .031. No teacher declared that he/she would never teach outdoors.

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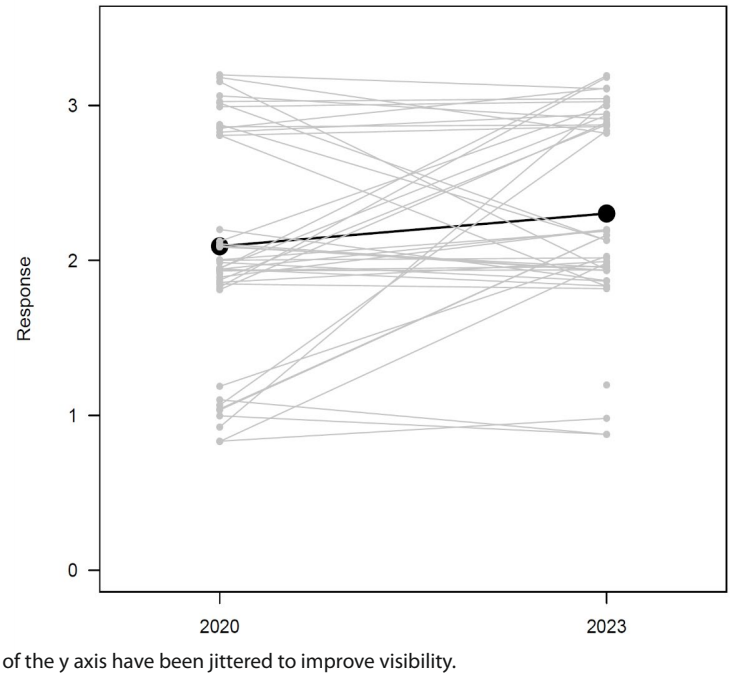
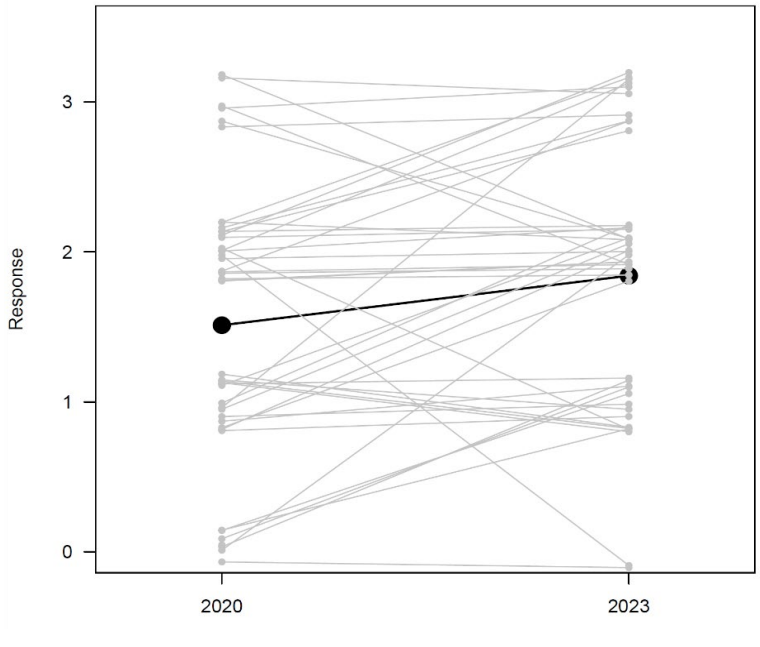
Figure 1
Outdoor Teaching Frequency Before the Online Course and 3 Years Later



Note. The values of the y axis have been jittered to improve visibility.

Completing the online course increased the frequency of student-designed research reported by teachers in delayed post-test (Figure 2): t (43) = -2.466, p = .018. The frequencies are coded as 0 = never, 1 = rarely, 2 = 2× per term or more often, 3 = monthly or more often. Completing the online course also increased the knowledge of arguments for outdoor teaching (ONLINE COURSE dataset).

Figure 2
Student-Designed Research Frequency Before the Online Course and 3 Years Later



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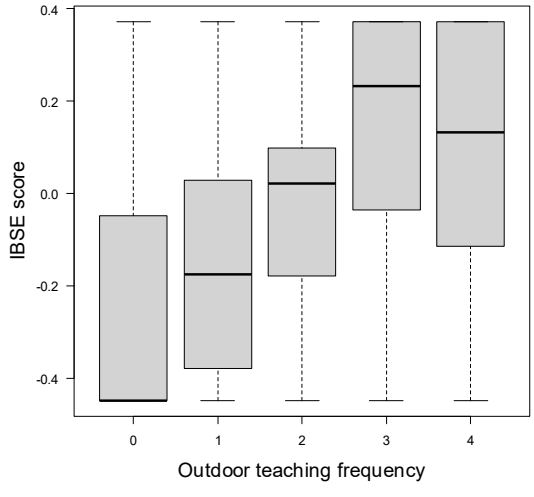
Correlation between inquiry frequency (measured as IBSE score, i.e. the score at the first axis of PCA summarizing variation in four variables measuring frequencies of different IBSE steps) and outdoor teaching frequency was found in the DOWNLOAD dataset (Figure 3). The correlation was significant using ANOVA ($F = 173.75$; $df = 1,794$; $p < .001$) and explains almost 18% of the variation in the IBSE score (*Adjusted R2* = 0.1785). Outdoor teaching frequency is coded as: 0 = never, 1 = rarely, 2 = 2× per term, 3 = monthly or more often, 4 = weekly.

Correlation between inquiry frequency (measured as IBSE score) and outdoor teaching frequency was found in the ONLINE COURSE dataset as well for all educators ($N = 718$) and school teachers only ($N = 360$). The correlation was significant using Spearman's rank correlation coefficient, for all educators ($\rho = .496$, $p < .001$) and school teachers only ($\rho = .389$, $p < .001$). These results are not shown.

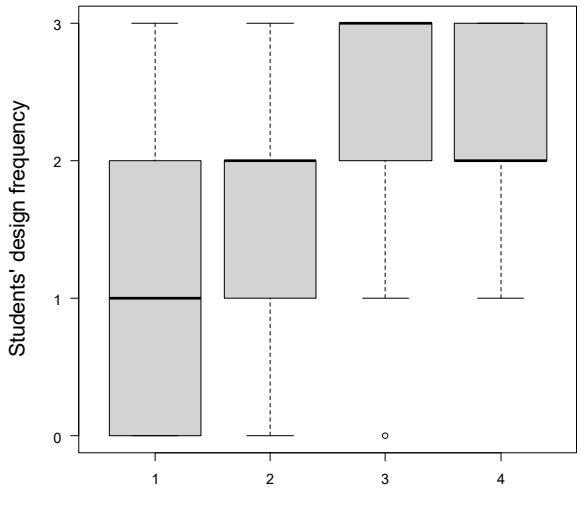
Figure 3
Relationship between IBSE score and Outdoor teaching frequency (N = 796)



Outdoor teaching frequency in the DOWNLOAD dataset was correlated with a particular IBSE step: student-designed research frequency (Figure 4). The correlation was significant using Spearman's rank correlation coefficient ($\rho = .454$, $p < .001$).

The optimal frequency of outdoor teaching that yielded the highest frequency in student-designed research was monthly or more often, dropping with a more regular frequency (weekly).

Figure 4
Relationship between Student-Designed Research Frequency (step of IBSE) and Outdoor Teaching Frequency (N = 796).



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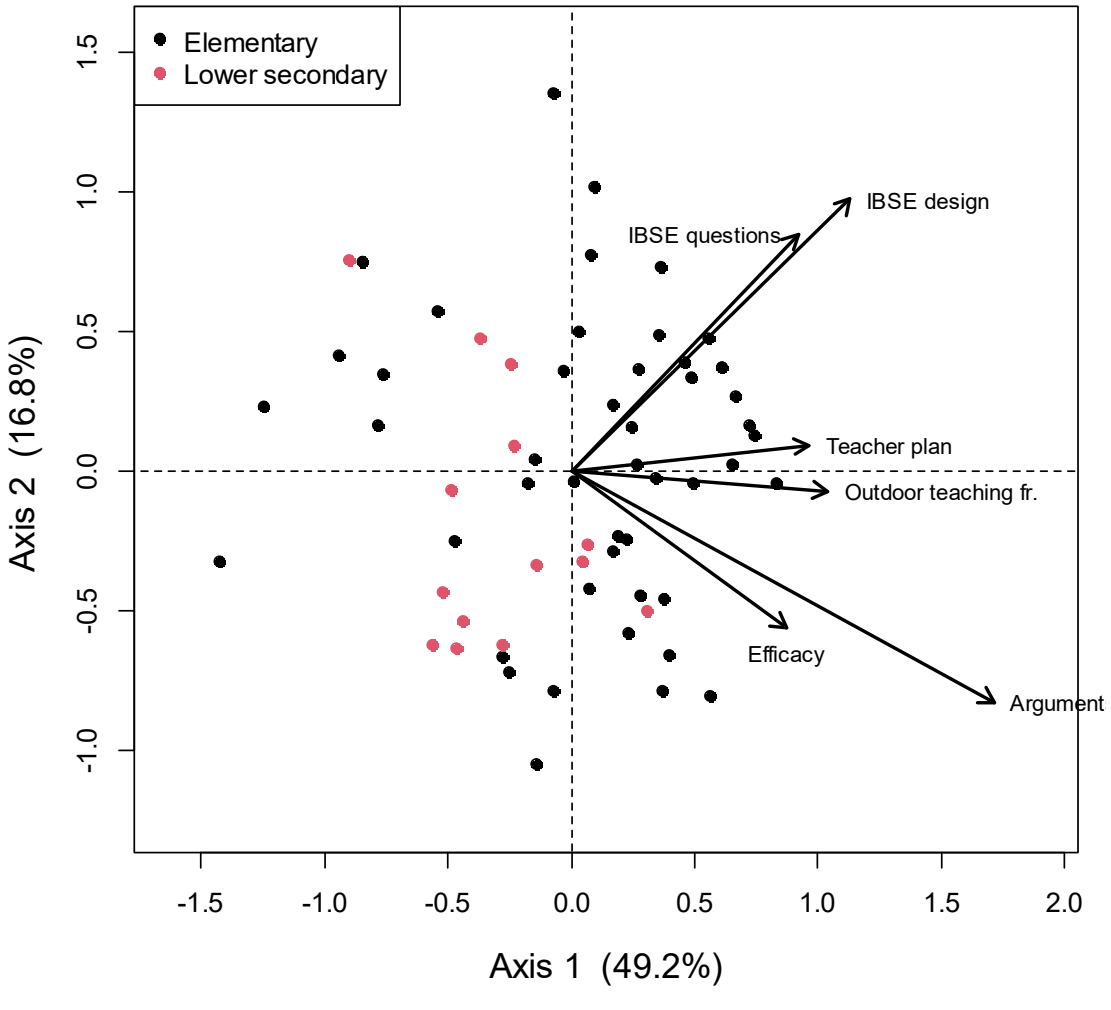
Teachers' characteristics from the delayed post-questionnaire after the online course regarding outdoor teaching, using IBSE, involving students in formulating research questions, planning, teachers' self-efficacy and influencing other colleagues were analyzed. Principal Component Analysis (PCA) showed that elementary school teachers were more active in all of the following characteristics. The first and the second axes explained 49.2% variation and 16.8% variation, respectively. The first axis divided teachers according to their activity or frequency in all variables. The second axis divided teachers into two groups, one focused on IBSE steps in their own practice and the other on using arguments to convince colleagues to teach outdoors more often (Figure 5).

Figure 5
Principal Component Analysis of Teacher Responses in Delayed Post-Questionnaire (N=74).



Discussion

The frequency of both outdoor teaching and using IBSE in the sample of teachers downloading materials is comparable to other surveys from the Czech Republic, although the sample came from teachers who were highly motivated. 26.5% of teachers who downloaded the teaching materials teach outdoors monthly. This is similar to Nepraš and Šikulová (2021), who found out that more than 30% of the sample of 120 primary school teachers teach outdoors regularly, and 80% reported that they would like to do it more often. Only 14% of primary school teachers entering the online course reported that they teach outdoors monthly. They were probably motivated to teach outdoors more often and that is why they enrolled in this voluntary professional development.

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The Czech School Inspectorate (Česká školní inspekce, 2018) has found a very low frequency of inquiry-based lessons, less than 4% of observed lessons. Although IBSE was not the main focus of the online course and teaching materials on the website Ucimesevenku.cz, the community of teachers interested in both outdoor teaching and inquiry overlaps, so we could presume the respondents to be more active in both. A correlation between the frequency of outdoor teaching and using IBSE or its aspect (student-designed research) was found. In the study, 25.2% of teachers who downloaded the teaching materials offered the opportunity for student-designed investigation on a monthly basis, while only 11.6% did so among teachers enrolling in the online course. The Czech School Inspectorate (Česká školní inspekce, 2018) researched science lessons, and according to the self-reported frequencies of teaching practices, only 16% of teachers claimed that their students performed an experiment that they would design themselves monthly.

Činčera and Kroufek (2021) found that only 19% of teachers see students as partners in the inquiry process and allow them to participate actively in the decisions about the design of the research, and only 5% of teachers attribute a leading role during inquiry to the students. In the survey on environmental literacy (Novosák et al., 2020), 32% reported using IBSE; from this subset, only 30% of teachers involved students in deciding about the inquiry process as a partner. It was found that 36% of teachers report using IBSE when enrolling in the online course, 11.6% report enabling students to design investigations monthly, and 29.6% do so twice per term. The teachers (DOWNLOAD dataset) in the study allowed students to design investigation monthly (25.2%) and twice per term (29%) which is clearly more frequent than in the Czech School Inspectorate surveys mentioned above. Nevertheless, it cannot be assessed if teachers see the students as leaders or only just participants in the decisions because the teachers' beliefs were not addressed in the questionnaires.

In the study of the self-reported frequency of IBSE in relationship to teachers' beliefs and their science teaching self-efficacy (Lucero et al., 2013), authors revealed a very low frequency of student-designed research among teachers in rural Ecuador. The teachers preferred structured inquiry. It was difficult for teachers to give up control, teachers did not ask students to formulate their own research question and define, by themselves, the research procedure. This was linked to their context beliefs: Teachers who believed that effective science teaching was possible in their schools (thanks to supportive colleagues and school management, appropriate scientific equipment etc.) also believed that effective performance was possible for students. The teachers from the present study actively sought support through the online community at Ucimesevenku.cz, and many of them supported their colleagues.

Impact of the Online Course and Potential Ambassadors of Outdoor Teaching and IBSE

The approach of the online course participants to student-designed research is more positive than among the teachers from the Czech School Inspectorate surveys. In the group of all educators (school teachers, home-schooling parents, preschool and early childhood educators, educators in non-formal settings), 28% of educators have declared that they offered this opportunity monthly before they enrolled in the online course (whereas only 11% teachers did so) and 33% educators do so after the online course. This rather high proportion among active online course participants is consistent with the findings about teachers' beliefs by Kotuľáková (2021). It revealed that Slovak teachers enrolling in the professional development course in IBSE highlight that they perceive their students as curious and active independent researchers and thinkers, see themselves as providers of a stimulating environment for cooperation, and acknowledge that students must construct their knowledge individually.

A correlation between the frequency of outdoor teaching and using IBSE or one of its aspects (student-designed research) was found. Two groups of active teachers after the course were identified, one focused on IBSE activities in their own class (outdoor inquiry enthusiasts) and the other influencing other colleagues and motivating them to teach outdoors more regularly using arguments retrieved from the online course (teaching outdoors ambassadors). Both groups were represented more by primary school teachers; participating lower-secondary school teachers were not so active regarding the frequency of outdoor teaching, convincing others, or using IBSE in their own class. This is in line with previous analysis of entry questionnaires prior to the course published in Čiháková (2021), with primary school teachers playing a more active role in influencing their colleagues.

The active role of primary school teachers in IBSE is rather unexpected as primary school teachers tend to worry about the extent of their personal knowledge of the science content, have lower self-confidence in teaching science in general and using IBSE in particular (Harlen, 2021). However, at the same time, their pedagogical

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knowledge enables them to encourage their students to attain inquiry skills. Primary school teachers have fewer obstacles (organizing lessons within a schedule, etc.) than lower-secondary teachers, and they have the pedagogical training and experience needed to organize group work that is useful for learning in outdoor settings. Primary school teachers usually experience difficulties in guiding students through the process of inquiry (Zion et al., 2007), regarding the formulation of a research question and the design of an investigation (Yoon et al., 2012). Nevertheless, the sample reported in the present study of highly motivated primary school teachers received support in the online course, used available teaching resources from the website Ucimesevenku.cz, and was inspired by other members of the Facebook group. According to their self-reported behavior, they were able to use the advantages of outdoor teaching for inquiry.

The opportunities for student-designed investigations are emphasized in the present study in accordance with the definition of inquiry (NRC, 1996) as involving: "making observations; posing questions; planning investigations; reviewing what is already known; using tools to gather, analyze, and interpret data; proposing answers; explanations and predictions and communicating the results." Therefore, teachers' role consisting of "asking students to make predictions and plan investigations" (Harlen, 2021) was addressed, although this step was reported rather rarely in other studies and surveys, and it is limited to lessons with the guided or open inquiry. Results from the questionnaires are based on self-reported behavior of teachers and may not reflect the reality correctly. However, they indicate that student-designed research is a part of the practice of the sample of highly motivated teachers.

This is in contrast to a recent study of video-taped inquiry-based lessons of primary and lower-secondary teachers from 20 Norwegian schools (Kersting et al., 2023) that coded the behavior of teachers through different phases of the inquiry cycle. It revealed that in none of the 73 observed lessons students planned investigations based on their own questions or predictions and that both primary and lower-secondary school students barely developed their own questions and hypotheses. Although the sample of teachers was selected from the schools regularly collaborating with university researchers which would implicate higher than average quality of inquiry, a high proportion of observed lessons did not include any elements of inquiry. In the inquiry lessons, the primary data was often collected according to a given recipe when students did practical work. All the videotaped lessons took place inside the classroom, and this could influence the results, as it is extremely difficult to videotape lessons outdoors, but this limitation is not mentioned by the authors.

Nevertheless, the authors (Kersting et al., 2023) compared the quality of IBSE between primary and lower-secondary schools summarizing that primary school students collected and documented data more systematically than lower-secondary students and that consolidations of results were slightly more emphasized and of higher quality at the lower-secondary than at the primary level. This indicates the potential for mutual collaboration between primary and lower-secondary teachers that would be beneficial to both groups.

Establishing a community of practice is an essential part of any successful teacher professional development program (Timperley et al., 2007). It cannot be fully substituted by online Facebook groups (as used in the online courses of TEREZA, Educational Centre), but it should be school-based or organized at a district level. Such professional learning communities are already widespread in the Czech Republic for language teachers (https://www.kellnerfoundation.cz/en/helping-schools-succeed) or for physics and chemistry teachers (Elixír do škol, https://www.elixirdoskol.cz). They are still missing for biology teachers in the Czech Republic, whereas they are widespread, e.g. in the USA, where Kelley et al. (2020) found that teachers who participated in a STEM community of practice increased their self-efficacy.

Drawing from the results, we would recommend involving both primary school teachers and lower-secondary biology teachers to become members of such learning communities. It would be beneficial as the primary and lower-secondary stage is mostly part of the same institution in the Czech Republic, but teachers rarely meet between the two stages. Inviting more experienced teachers from other schools or districts as ambassadors of outdoor education and IBSE would be useful. Cooperation with external experts is an important part of effective professional development, according to Timperley et al. (2007), and inspiration from colleagues from other schools can probably be accepted by their peers better than from external experts from universities or NGOs. That is why highly motivated teachers such as those enrolled in professional development programs (including online courses focused on IBSE phases or student assessment in outdoor education and IBSE) are needed.

Moreover, it is important that lower-secondary teachers, with their specific needs, interests, and limitations, are inspired by their more experienced peers. The organizer of the Ucimesevenku.cz online platform (TEREZA, Educational Centre) has recently promoted online courses on IBSE lectured by lower-secondary teachers. They

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address the same community of teachers (followers of the website and social media of Ucimesevenku.cz) and several participants of this study were enrolled or already participated in the IBSE online course when they filled the delayed post-questionnaire. TEREZA, Educational Centre provides new teaching materials, e.g. inquiry about climate change and carbon cycle. This is in line with the recommendation of Novosák et al. (2024) that Czech teachers would appreciate practically oriented support for their pedagogical work (e.g. methodological guides, worksheets, suggestions for experiments) to involve inquiry and enhance scientific literacy. Further research for evaluating the benefits of particular teaching resources is needed.

It is striking that using outdoor education as a means for promoting inquiry is hardly ever mentioned among the recommendations for introducing IBSE through teacher professional development programs (further called PDP): Harlen and Allende (2009) recommended enabling teachers to use the environment and taking advantage of the range of contexts in which teachers learn inside and outside the classroom, while a more recent publication (Harlen, 2021) emphasized only the role of ICT, thought-provoking questions and scaffolding for initial teacher training and professional development in IBSE. This can be attributed to the fact that outdoor teaching per se can be challenging for an inexperienced teacher (Rickinson et al., 2004), and this could discourage participants from both outdoor teaching and IBSE if the PDP is not thoughtfully organized.

When entering the combination of key words "outdoor AND (IBSE OR (inquiry AND education)) AND professional development" into the Web of Science Core Collection, only 13 publications were found. Apart from the already cited research from the present author (Čiháková, 2021), these articles were related to ICT or mobile applications developed by teachers for students or were focused solely on inquiry in geography.

Although outdoor education was recognized to support the implementation of the IBSE approach on a large scale (LOCM, 2006; Rocard et al., 2007), it did not result in wider adoption of PDPs. Outdoor Education or Learning in Outdoor Contexts was used in dissemination projects at the European, national or regional level, e.g. INQUIRY Project that took place in botanical gardens and nature history museums in 11 European countries (Kapelari, 2015) and project Oborový mentoring (Čiháková, 2021) in the Czech Republic. However, as the results from these PDPs were not published in peer reviewed journals but rather as final project reports only, the potential of outdoor education for promoting IBSE is not recognized and widely exploited by researchers or teacher educators.

The connection between outdoor education and IBSE is difficult to trace in the literature, probably due to diverse labels used for different forms of learning outside the classrooms, e.g. outdoor learning (Rickinson et al., 2014), outdoor play and learning in natural environments (Gill, 2011) or learning in outdoor contexts (Kapelari, 2015). In addition, it seems that the authors dealing with either science education or outdoor education (emphasizing adventure or environmental aspects) publish in different journals and attend different conferences or international projects.

Including outdoor teaching, at least for the first phase of the inquiry process, would be beneficial because inquiry starts with a question or problem raised by a new event or experience (Harlen, 2021) that happens outdoors naturally, both in school practice with students and during PDP for teachers.

Limitations of Self-Reported Strategies and Behavior

The results of the present study can only be generalized for outdoor teaching enthusiasts, as the sample used is retrieved from the questionnaires filled out by teachers visiting a specialized website and online course. Among teachers in general, the frequencies of outdoor teaching and IBSE are probably lower (Česká školní inspekce, 2018; Novosák et al., 2024).

As the principles of the IBSE approach were not clearly described in the questionnaire because it was part of one question (to assess how well it is understood by the respondents), it could result in overestimating the frequencies of particular inquiry activities. In the previous study, it was found that teachers report involving students in investigation design even though they do not have the knowledge of IBSE (Čiháková, 2021). This result is surprising, as this aspect of IBSE is usually not so easily adopted (Bernard & Dudek-Różycki, 2020; Lucero et al., 2013) and even after an extensive professional development program, teachers do not report it.

The self-reported teaching practices in the questionnaires are generally overestimated (Kotuľáková et al., 2022; Monet & Etkina, 2008). Therefore, only questions regarding the frequencies of particular practices were included, and teachers were not expected to respond to more complex questions describing their skills or quality of teaching practice.

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According to Kotuľáková et al. (2022), the areas that are most misinterpreted and overestimated by teachers include formulating research questions, analyzing data, and drawing conclusions, which the authors describe as the most effective processes in student learning. Similarly, when observing lessons in rural schools in Ecuador, authors compared the answers from the questionnaires with reality (Lucero et al., 2013) and found a complete lack of inquiry teaching. Specifically, there was no space for students' questions (3 students' questions vs. 1600 teachers' questions in 20 science lessons), while according to the questionnaires, structured inquiry was reported by teachers.

This limitation was addressed in this study by asking the teachers to invite the researchers to their outdoor teaching lesson for observation and to participate in the interviews to compare the answers with the observed teaching practices (mainly IBSE – students' questions and student-designed research). The phase of designing the investigations could be supported by teachers' interventions as described by van Uums et al. (2016) in 3 domains: Procedural – Scaffolding the procedure of formulating a research question with criteria and examples; Epistemic – Explaining design criteria of a proper investigation and questioning students about considerations regarding their research design, such as the number of research subjects and measurements; Social – Facilitating students' collaboration, for example, by dividing roles such as chairman, and discussing individual responsibilities regarding these roles.

Conclusions and Implications

The present study showed that developing opportunities for active participation of students in the inquiry can be supported indirectly, through voluntary professional development (online course) focused on outdoor teaching. As outdoor teaching naturally offers the opportunity for formulating students' own research questions and participation in the design of investigations, the future professional development courses should use this advantage and could address highly motivated teachers experienced in outdoor education. More research on combining IBSE and outdoor teaching would bring helpful insights for designing professional development programs for in-service teachers and pre-service teacher training.

Active teachers, particularly primary school teachers, have proven to serve as ambassadors of both outdoor teaching and IBSE. It is important that lower-secondary teachers, with their specific needs, interests, and limitations, can be inspired by their more experienced peers. Hopefully, the current ongoing education reform of the state curriculum will highlight the need for change from a teacher-centered transmission approach to more student-centered forms of science education. The groups of teachers, such as outdoor inquiry enthusiasts and outdoor teaching ambassadors, may become the centers of future learning communities, where both primary and lower-secondary teachers could share their experience. More active lower-secondary teachers are needed to be educated in IBSE to serve as role-models for their peers. Professional development should also aim at enhancing their motivation and skills to share experience with their peers.

When voluntary online courses in different aspects of IBSE (e.g. assessment or using ICT) are offered, we recommend combining them with outdoor teaching and aiming at experienced outdoor inquiry enthusiasts to enhance their teaching skills. Offering free teaching materials for beginners to download can probably also support the frequency and quality of IBSE, but more research on this topic is needed.

However, unless the professional development of science teachers starts to follow mandatory rules and clear goals, the desirable changes in science lessons in Czech schools in general cannot be expected.

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References

Bandura, A. (1997). *Self-efficacy: The exercise of control.* Macmillan.

Bentsen, P., & Jensen, F. S. (2012). The nature of udeskole: Outdoor learning theory and practice in Danish schools. *Journal of Adventure Education & Outdoor Learning*, *12*(3), 199–219. https://doi.org/10.1080/14729679.2012.699806

https://doi.org/10.33225/jbse/24.23.599

ISSN 1648–3898 /Print/
ISSN 2538–7138 /Online/

Bernard, P., & Dudek-Różycki, K. (2020). The impact of professional development in inquiry-based methods on science teachers' classroom practice. *Journal of Baltic Science Education*, *19*(2), 201–19. https://doi.org/10.33225/jbse/20.19.201

Bybee, R. W. (2002). Scientific inquiry, student learning, and the science curriculum. In R. W. Bybee (Ed.), *Learning science and the science of learning* (pp. 25–64). NSTA Press

Česká školní inspekce (2018). Rozvoj přírodovědné gramotnosti na základních a středních školách ve školním roce 2016/2017. Tematická zpráva. [Development of scientific literacy at primary and secondary schools in 2016/2017. Thematic report]. http://www.csicr.cz/cz/Aktuality/Tematicka-zprava-–-Rozvoj-prirodovedne-gramotnosti

Chan, K. M. A., Balvanera, P., Benessaiah, K., Chapman, M., Diaz, S., Gomez-Baggethun, E., Gould, R., Hannahs, N., Jax, K., Klain, S., Luck, G. W., Martín-López, B., Muraca, B., Norton, B., Ott, K., Pascual, U., Satterfield, T., Tadaki, M., Taggart, J., & Turner, N. (2016). Why protect nature? Rethinking values and the environment. *Proceedings of the National Academy of Sciences of the United States of America*, *113*, 1462–1465.

Chawla, L. (2015). Benefits of nature contact for children. *Journal of Planning Literature*, *30*(4), 433–452. https://doi.org/10.1177/0885412215595441

Chmelová, Š. (2021). Jak učitelé využívají venkovní prostředí pro výuku vzdělávací oblasti Člověk a jeho svět. [How teachers use education outside the classroom for instruction within the educational area Humans and their world]. *Pedagogická orientace*, *31*(2), 178–200.

Čiháková, K. (2021). IBSE and outdoor education activates both children and teachers. In M. Rusek, M. Tóthová & K. Vojíř (Eds.), *Project-based education and other activating strategies in science education XVIII.* Conference proceedings (p. 26–35). Univerzita Karlova. https://pages.pedf.cuni.cz/pbe/files/2022/10/ProceedingsPBE2021_final.pdf

Činčera, J., & Holec, J. (2016). Terénní výuka ve formálním vzdělávání. [Outdoor education in formal education]. *Envigogika*, *11*(2), 0-20. https://doi.org/10.14712/18023061.533

Činčera, J., & Kroufek, R. (2021). Metodika hodnocení environmentální gramotnosti žáků. [Assessing environmental iteracy]. Ministerstvo životního prostředí. 1–58. https://www.mzp.cz/C1257458002F0DC7/cz/environmentalni_vzdelavani_poradenstvi/$FILE/OFDN-Metodika_hodnoceni_ekogramotnosti-20210415.pdf

Činčera, J., Zálešák, J., Kolenatý, M., Šimonová, P. & Johnson, B. (2021). We love them anyway: Outdoor environmental education programs from the accompanying teachers' perspective. *Journal of Outdoor and Environmental Education*, *24*(3), 243–257. https://doi.org/10.1007/s42322-021-00084-9

Daniš, P. (2018). *Tajemství* školy *za* školou*: Proč učení venku v přírodě zlepšuje vzdělávací výsledky, motivaci a chování* žáků. [The mystery of the school behind the school: Why learning outdoors in nature improves learning outcomes, motivation and behaviour.] Ministerstvo životního prostředí

de Jong, T. (2006). Scaffolds for computer simulation based scientific discovery learning. In J. Elen & R. E. Clark (Eds.), *Dealing with complexity in learning environments* (pp. 107–128). Elsevier Science Publishers.

Furtak, E. M., Seidel, T., Iverson, H., & Briggs, D. C. (2012). Experimental and quasi-experimental studies of inquiry-based science teaching: A meta-analysis. *Review of Educational Research*, *82*(3), 300–29.

Gill, T. (2011). *Children and nature: A quasi-systematic review of the empirical evidence.* London Sustainable Development Commission. https://www.london.gov.uk/sites/default/files/lsdc_-_sowing_the_seeds_-_literature_review_2011.pdf

Glackin, M. (2016). 'Risky fun' or 'Authentic science'? How teachers' beliefs influence their practice during a professional development programme on outdoor learning. *International Journal of Science Education, 38*(3), 409–433. https://doi.org/10.1080/09500693.2016.1145368

Harlen, W., & Allende, J. (2009). *Teacher professional development in pre-secondary school inquiry-based science education (IBSE).* University of Chile.

Harlen, W. (2021). *The case for inquiry-based science education – IBSE*. InterAcademy Partnership.

Hmelo-Silver, C. E., Duncan, R. G., & Chinn, C. A. (2007). Scaffolding and achievement in problem-based and inquiry learning: A response to Kirschner, Sweller, and Clark (2006). *Educational Psychologist*, *42*(2), 99–107. https://doi.org/10.1080/00461520701263368

Johnson, B., & Činčera, J. (2021). Relationships between outdoor environmental education program characteristics and children's environmental values and behaviors. *Journal of Adventure Education and Outdoor Learning, 23*(2), 184–201. https://doi.org/10.1080/14729679.2021.2001756

Kapelari, S. (2015). *Garden learning: A study on European botanic gardens' collaborative learning processes*. Ubiquity Press.

Kelley, T. R., Knowles, J. G., Holland, J. D., & Han, J. (2020). Increasing high school teachers' self-efficacy for integrated STEM instruction through a collaborative community of practice. *International Journal of STEM Education, 7*, 1–13. https://doi.org/10.1186/s40594-020-00211-w

Kotuľáková, K. (2019). Identifying teachers' beliefs prior to CPD training focusing on an inquiry-based approach in science education. *Research in Science Education*, *1*(29). https://doi.org/10.1007/s11165-019-9841-0

Kotuľáková, K., Orolinova, M., Priškinová, N., Schubertová, R. & Tóthová, R. (2022). Congruence and Discrepancy between observation and teachers' self-report of inquiry-based instruction. *Chemistry-Didactics-Ecology-Metrology*. https://doi.org/27. 10.2478/cdem-2022-0002

LOCM (2006). Learning outside the classroom manifesto. Department for Education and Skills, DfES Publications. https://thegrowingschoolsgarden.org.uk/downloads/lotc-manifesto.pdf

Lucero, M., Valcke, M., & Schellens, T. (2013). Teachers' beliefs and self-reported use of inquiry in science education in public primary schools. *International Journal of Science Education, 35*(8), 1407–1423. https://doi.org/10.1080/09500693.2012.704430

https://doi.org/10.33225/jbse/24.23.599

ISSN 1648–3898 /Print/
ISSN 2538–7138 /Online/

Malone, K. (2008). *Every experience matters: An Evidence based research report on the role of learning outside the classroom for children's whole development from birth to eighteen years*. Farming and Countryside Education for UK Department Children, School and Families.

McConney, A., Oliver, M. C., Woods-McConney, A., Schibeci, R., & Maor, D. (2014). Inquiry, engagement, and literacy in science: A retrospective, cross-national analysis using PISA 2006. *Science Education*, *98*(6), 963–980. https://doi.org/10.1002/sce.21135

Monet, J., & Etkina, E. (2008). Fostering self-reflection and meaningful learning: Earth science professional development for middle school science teachers. *Journal of Science Teacher Education, 19*(5), 455–475. https://doi.org/10.1007/s10972-008-9106-7

National Research Council, (2012). *A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas.* The National Academies Press. https://nap.nationalacademies.org/catalog/13165/a-framework-for-k-12-science-education-practices-crosscutting-concepts

Nepraš, K., & Šikulová, R. (2021). Odkud a kam směřuje venkovní výuka? Historie, současnost a trendy ve venkovní výuce v kontextu vzdělávacích teorií [From where and where does outdoor teaching go? History, present and trends in outdoor teaching in the context of educational theories]. *Pedagogická orientace, 31*(2), 158–177. https://doi.org/10.5817/PedOr2021-2-158

Novosák J., Novosáková J., Suchomel P., Pavlas T. & Dvořák J. (2024): Přírodovědná gramotnost a přírodovědné vzdělávání na základních a středních školách. Tematická zpráva. [Development of scientific literacy at primary and secondary schools. Thematic report]. Česká školní inspekce, https://www.csicr.cz/CSICR/media/Prilohy/2024_p%c5%99%c3%adlohy/Dokumenty/TZ_Prirodovedna_gramotnost_a_prirodovedne_vzdelavani_final_13032024.pdf

Novosák, J., Suchomel P., Dvořák J., & Andrys O. (2020). Environmentální výchova na základních školách ve školním roce 2019/2020. Tematická zpráva. [Development of environmental literacy at primary schools in the school year 2019/2020. Thematic report]. Česká školní inspekce, https://www.csicr.cz/Csicr/media/Prilohy/PDF_el._publikace/Tematick%C3%A9%20zpr%C3%A1vy/TZ_Environmentalni-vychova-na-ZS-2019-2020.pdf

Office for Standards in Education, Children's Services and Skills (2013). Maintaining curiosity: A survey into science education in schools. https://www.gov.uk/government/publications/maintaining-curiosity-a-survey-into-science-education-in-schools

Oliver, M., McConney, A., & Woods-McConney, A. (2019). The efficacy of inquiry-based instruction in Science: a Comparative Analysis of Six Countries Using PISA 2015. *Research in Science Education*, *51*(S2), 595–616. https://doi.org/10.1007/s11165-019-09901-0

Oksanen, J., Blanchet, F.G., Friendly, M., Kindt, R., Legendre, P., McGlinn, D., Minchin, P. R., O'Hara, R. B., Simpson, G. L., Solymos, P., Stevens, M. H. H, Szoecs, E., Wagner, H. (2020). Vegan: Community Ecology Package. R package version 2.5-7. https://cran.r-project.org/web/packages/vegan/index.html

Pedaste, M., Mäeots, M., Siiman, L. A., De Jong, T., Van Riesen, S. A., Kamp, E. T., Manoli, C. C., Zacharia, Z. C., & Tsourlidaki, E. (2015). Phases of inquiry-based learning: Definitions and the inquiry cycle. *Educational Research Review, 14*, 47–61. https://doi.org/10.1016/j.edurev.2015.02.003

R Core Team (2021). R: *A language and environment for statistical computing*. R Foundation for Statistical Computing. https://www.r-project.org

Radvanová, S., Čížková, V., & Martinková, P. (2018). Mění se pohled učitelů na badatelsky orientovanou výuku? [Are teachers' attitudes to inquiry-based learning changing?]. *Scientia in Educatione, 9*(1). 81–103. https://doi.org/10.14712/18047106.105

Rickinson, M., Dillon, J., Teamey, K., Morris, M., Choi, M. Y., Sanders, D., & Benefield, P. (2004). *A review of research on outdoor learning*. National Foundation for Educational Research, Shrewsbury and King's College London.

Rocard M., Csermely, P., Jorde, D., Lenzen, D, Walberg-Henriksson, H. & Hemmo, V. (2007). Science Education Now: A renewed Pedagogy for the future of Europe. Report EU22-845.

Sjøberg, S. (2018). The power and paradoxes of PISA: Should inquiry-based science education be sacrificed to climb on the rankings? *Nordic Studies in Science Education, 14*(2), 186–202.

Smetáčková, I., & Vozková, A. (2021). Učitelské sdílení profesních zkušeností – aktuální pohled z českých skol. [Teachers' sharing of professional experiences – perspective from Czech schools]. *Pedagogika*, *71*(2). https://doi.org/10.14712/23362189.2020.1858

Smetáčková, I., Topková, P., & Vozková, A. (2017). Vývoj a pilotáž škály učitelské self-efficacy. [Development and piloting of a teacher self-efficacy scale]. *Lifelong Learning – celoživotní vzdělávání*, *7*(2), 26–46.

Stuchlíková, I., Janík, T., Rokos, L., Minaříková, E., Samková, L., Najvar, P., Hošpesová, A., & Janíková, M. (2024). Hyperspace pro formativní hodnocení a badatelsky orientovanou výuku: Koncepce – vývoj – aplikace.]. *Pedagogická orientace*, *33*(2). https://doi.org/10.5817/pedor2023-2-185

Tschannen-Moran, M., & Hoy, A. W. (2001). Teacher efficacy: Capturing an elusive construct. *Teaching and Teacher Education, 17*(7), 783–805. https://doi.org/10.1016/s0742-051x(01)00036-1

van Uum, M. S. J., Verhoeff, R. P., & Peeters, M. (2016). Inquiry-based science education: Towards a pedagogical framework for primary school teachers. *International Journal of Science Education*, *38*(3), 450–469. https://doi.org/10.1080/09500693.2016.1147660

Vácha, Z., & Petr, J. (2013). Inquiry based education at primary school through school gardens. *Journal of International Scientific Publications: Education Alternatives, 4*, 219–230.

Waite, S. (2020). Where are we going? International views on purposes, practices and barriers in school-based outdoor learning. *Education Sciences*, *10*, 311; https://doi.org/10.3390/educsci10110311

https://doi.org/10.33225/jbse/24.23.599

ISSN 1648–3898 /Print/
ISSN 2538–7138 /Online/

Waite, S., Bølling, M., & Bentsen, P. (2015). Comparing apples and pears? A conceptual framework for understanding forms of outdoor learning through comparison of English forest schools and Danish udeskole. *Environmental Education Research*. https://doi.org/10.1080/13504622.2015.1075193

Yang, X., & Wang, Q. (2019). Factors influencing science teachers' self-efficacy. *International Journal of Environmental and Science Education, 14*(8), 445–454.

Yoon, H.-G., Joung, Y. J., & Kim, M. (2012). The challenges of science inquiry teaching for pre-service teachers in elementary classrooms: Difficulties on and under the scene. *Research in Science Education, 42*(3), 589–608.

Zion, M., Cohen, S., & Amir, R. (2007). The spectrum of dynamic inquiry teaching practices. *Research in Science Education, 37*(4), 423–447.

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